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in cooperation with
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of
THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

SPINNING AND FIBER PROPERTIES OF SIX AMERICAN UPLAND COTTONS

GROWN AT STONEVILLE, MISS., CROP OF 1939

By

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PURPOSE OF TESTS

The United States Department of Agriculture, through its Bureau of Plant Industry and Agricultural Marketing Service, is cooperating with several cotton growing States in an effort to obtain more complete information on the relationship of variety, location, and season to the quality of cotton grown. For this study, 8 series of each of 16 varieties of cotton have been grown at each of 14 locations across the Cotton Belt during each of the 3 crop years, 1935, 1936, and 1937. Cotton fiber and spinning tests are being conducted at the laboratories of the Agricultural Marketing Service at College Station, Tex., on more than 700 of these samples, and it

1/ These tests were conducted at College Station, Tex., in cooperation with the Agricultural and Mechanical College of Texas and the Bureau of Plant Industry, U. S. Dept. Agr., by R. L. Lee, Jr., and staff of the Agricultural Marketing Service, U. S. Dept. Agr., under the general direction of M. E. Campbell. The study is a part of the program of cotton quality and standardization under the leadership of R. W. Webb, Principal Cotton Technologist, Agricultural Marketing Service.

is expected that the work will be completed in the near future. A preliminary report covering some of the findings obtained from samples of cotton from the first two of these crops was recently presented. 2/

The tests are already proving valuable in providing data with respect to the fiber and spinning properties of these 16 varieties. Because new varieties and new strains are continually being developed by private cotton breeders, however, State experiment stations, and Federal Cotton breeding stations, it is inevitable that before these tests can be completed, there will be a need for similar information on types of cotton not included in these studies. Such a need is made urgent by the fact that with the growth of the single variety community plan, cotton growers find it imperative to select the variety of cotton best suited for their individual localities, not only on the basis of its growth characteristics but also on the basis of the desirability of its lint to cotton manufacturers.

The tests described in this report were conducted, therefore, for the purpose of making available some information on the fiber and spinning properties of six varieties or strains of cotton not included in the regional variety tests.

THE COTTONS

The cottons included in these tests were produced in 1939 by the Delta Experiment Station at Stoneville, Miss. 3/

Coker 100-2-1 (also called Coker 200, Strain 1)
D. & P. L. 11-A (Also called Deltapine A)
D. & P. L. 12 (also called Deltapine 12)
Delfos 6
Miller
Stoneville 2B

Planting seed for the varieties was obtained from the following sources: Coker 100-2-1, Coker Pedigreed Seed Company, Hartsville, S. C.; D. & P. L. 11-A and D. & P. L. 12, Delta and Pine Land Company, Scott, Miss.; Delfos 6,, Delta Experiment Station, Stoneville, Miss.; Miller, Mississippi Agricultural Experiment Station, State College, Miss.; and Stoneville 2B, Stoneville Pedigreed Seed Company, Stoneville, Miss.

2/ "Preliminary Report of Cotton Spinning and Related Fiber Studies, in Connection with the Regional Variety Series, Crops of 1935 and 1936," an address presented by Malcolm E. Campbell at a meeting of the American Society of Agronomy, New Orleans, La., November 23, 1939.

3/ These cottons were produced under the direction of H. C. McNamara, Senior Agronomist, Bureau of Plant Industry, and Superintendent, Delta Experiment Station, Stoneville, Miss.

The varieties were planted in eight series of 4-row plots with rows 60 feet long in a doubly restricted but otherwise random design in order to simplify the statistical analysis of the data. Planting was done on April 21 on typical Sarpy fine sandy loam soil. Prior to planting each plot had received an application of 30 pounds of nitrogen per acre. The test was harvested on August 29 and September 30.

Excessive rainfall was recorded in January and February. March was normal. May was rather dry, and June wet, followed by a very dry July, August, September, and October. Thus, the cotton season was marked by two extremely wet periods and two very dry periods. During the latter part of May and the month of June a period of prolonged rainfall was encountered, so that the cotton was not cultivated for several weeks. This rainfall terminated abruptly, leaving the plants in rather spindly, sappy condition at the beginning of an extended drought that lasted practically all the summer and into the fall. Very little rain was recorded, and the open bolls were fairly free from moisture damage or rainfall of any kind. On a few of the plots the plants showed some signs of wilting during the latter part of August, but in most of the plots they grew very tall and rank, setting a heavy crop of bolls that matured in good condition during the hot, dry weather.

The ginning of the samples was done at the Ginning Laboratory of the U. S. Department of Agriculture at Stoneville. 4/ Before the cottons were ginned, portions of seed cotton of the first and second pickings were mixed in proportion to the yields from the two pickings. The seed cotton was handled at the gin by a telescope, from which it was passed to a separator and deposited on the floor of the laboratory; it was then passed through a small drum feeder, and ginned on a 10-saw, plain front gin.

Moisture determinations made on the seed cotton, seed, and ginned lint at the time of ginning showed that the samples were unusually dry, probably because the weather in the field prior to picking was hot and dry. Differences in moisture content among the six cottons were small.

The samples of ginned lint were pressed into small bales and sent to the spinning laboratory of the Agricultural Marketing Service at College Station, Tex., for fiber and spinning tests.

TEST PROCEDURE

Upon receipt of the miniature bales at the Texas laboratory, representative samples were drawn and transmitted to the Appeal Board of Review Examiners in Washington for classification. Additional samples were reserved at the same time for fiber tests. The remainder, amounting

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4/ The samples were ginned by W. J. Martin, Associate Cotton Technologist, Agricultural Marketing Service.

to from 5 to 10 pounds of lint in each instance, was weighed and passed through the various machines of the spinning laboratory and spun into yarn according to the usual practice, following the "small sample" technique. This technique differs from that employed with large samples chiefly in that the sample is passed through the finisher picker twice, instead of through the opener, breaker picker, and finisher picker; and in the care and degree of precision required in handling and determining the proper lengths of stock at each process. With small samples it is not feasible to make quantitative measurements of each type of picker and card waste, therefore only the total waste losses are reported at the first and second processes of picking and at the card. The values for total waste removed by the card, however, are adjusted to the extent of correcting the percentages of cylinder and doffer strips, with the use of an empirical formula developed in the laboratories of the Agricultural Marketing Service, to values that might be expected when carding full-sized laps of the same cotton. Otherwise, the card waste percentages would appear to be abnormally high.

Except for the Miller cotton, which was classed as 15/16 inch in staple, the cottons were spun into 22s, 44s, and 60s carded warp yarns, with twist multipliers selected on the basis of staple length of cotton to give the optimum skein strength of yarn. In view of the shorter staple length of the Miller cotton it was spun into 22s, 36s, and 50s.

As the material passed through the various machines, observations were made of any outstanding characteristic that the cottons might show. When the yarns had been spun they were tested for skein strength and size, single strand strength, and appearance. In addition a portion of the roving was spun into 23s yarn with a 4.00-twist multiplier and then twisted into 23/5/3 tire cord with 18 turns per inch (Z twist) in the ply and 8 turns per inch (S twist) in the cable. These cords were later tested for strength, elongation at the 10-pound load, moisture regain, and yards per pound.

Fiber tests included length arrays made with the Suter-Webb sorter, and determinations of Chandler bundle strength, fineness in terms of weight per inch, and percentage, by number, of thin-walled fibers.

Samples of the spun yarns were examined microscopically, and the number of neps and seed-coat fragments in a 50-yard length of each sample was counted. 5/

Except in the picker room, temperature and humidity were held as nearly constant as possible by precision-controlled air-conditioning

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5/ The counts of neps and seed-coat fragments were made under the supervision of Dr. Norma L. Pearson, Associate Cotton Technologist, Bureau of Plant Industry.

systems. The following conditions were maintained: card room, 60% R. H., 75° F.; spinning room, 70% R. H., 75° F.; fiber and yarn testing, 65% R. H., 70° F.

The test results, together with a discussion of them, are presented below:

RESULTS

Classification - It may be seen from table 1 that the cottons ranged in grade from Strict Low Middling plus for the Coker 100-2-1 and Delfos 6 to Middling plus for the Miller, a range of one full grade. Staple lengths varied from 15/16 inch for the Miller cotton to 1-3/32 inches for the Coker 100-2-1 and Delfos 6 cottons. There was no noticeable difference in the grade or staple of the two strains of D. & P. L. cotton included in the test.

Table 1. - Grade and staple length of cotton tested

Variety	Grade	Staple length
		Inches
Coker 100-2-1	SLM+	1-3/32
D. & P.L. 11A	M	1-1/32
D. & P. L. 12	M	1-1/32
Delfos 6	SLM+	1-3/32
Miller	M+	15/16
Stoneville 2B	M	1-1/16

Fiber Properties - Data relating to the length, fineness, percentage of thin-walled fibers, and Chandler bundle strength are presented in table 2. Although the fiber array lengths maintain, in general, somewhat the same relation as was observed by the classers for staple length, it may be seen that Delfos 6 was found to be significantly longer than the Coker 100-2-1 at the 25-percent point.

The Miller cotton possessed the lowest coefficient of variability, 24.07 percent, possibly because it was somewhat shorter than the others. The other five cottons did not vary greatly in this respect and may be considered to possess average length variability.

Table 2. - Fiber properties of cottons tested

Variety	Length			Fineness		Thin-walled fibers	Chandler bundle strength
	25 per-cent point	Mean	Coeff. of varia-bility	Weight per inch	Fibers in cross-section of 22s yarn		
	Inches	Inches	Percent	10^{-4} Mgs.	Number	Percent	1000 lbs/ sq. in.
Coker 100-2-1	1.266	1.060	28.21	42.0	162	33.52	80.7±.6
D. & P.L. 11A	1.191	1.007	26.81	45.9	149	25.09	79.7±.3
D. & P. L. 12	1.170	.982	27.60	45.0	152	28.80	77.5±.5
Delfos 6	1.370	1.095	28.86	41.3	165	23.73	76.4±.5
Miller	1.093	.943	24.07	53.4	128	19.23	78.1±.4
Stoneville 2B	1.251	1.052	27.76	40.8	167	30.19	79.7±.4

The fiber fineness in terms of weight per inch varied from 40.8 to 45.9 ten-thousandths of a milligram for the five longer cottons, whereas the Miller was considerably coarser, with a fiber weight of 53.4 ten-thousandths of a milligram per inch. It is interesting, in this connection, that the Miller cotton is similar to Rowden in this respect, namely that it possesses a relatively high weight per inch. Miller was derived from the Rowden variety. (The term "10^{-4} Mgs." used in the table is simply a mathematical abbreviation signifying "ten-thousandths of a milligram," and is used to conserve space.)

The data on the number of fibers in a cross section of 22s yarn were obtained from the values for fiber weight per inch. They are given merely to present a somewhat different picture as to the significance of fiber fineness.

In percentage of thin-walled fibers, two of the cottons, Delfos 6 and Miller, are rather low, the Miller outstandingly so with a percentage of 19.23. On the other hand the value for the Coker 100-2-1, 33.52 percent, is slightly higher than the average usually obtained for American upland cottons of this length. In connection with the data on percentage of thin-walled fibers it should be mentioned that the full significance of this measure as an attribute of quality is not clearly understood at the present time. Therefore, within the range of maturity covered by the six cottons, it is not possible to say much about the relative desirability

of these samples from such a standpoint.

Chandler bundle strengths are neither outstandingly high nor low for these six cottons, although it may be pointed out that it is generally held that cottons possessing strengths below about 80,000 pounds per square inch leave something to be desired with respect to strength. It has already been shown (see footnote 2) that soil and climatic conditions usually have a significant influence on cotton-fiber strength, and it is entirely possible that any or all of these cottons might have given somewhat higher strengths had they been grown under other conditions.

Manufacturing waste - The percentages of picker and card waste removed from each of the cottons are shown in table 3. The total loss ranged from 6.22 percent for the D. & P. L. 12 cotton to 6.84 percent for the Coker 100-2-1 cotton. This range may be considered a narrow one, particularly in view of the fact that the samples were small.

Table 3. - Grade and manufacturing waste for cottons tested

Variety.......	Coker 100-2-1	D.&.P.L. 11A	D.&.P.L. 12	Delfos 6	Miller	Stoneville 2B
Grade	SLM+	M	M	SLM+	M+	M
Kind of waste:	Percent	Percent	Percent	Percent	Percent	Percent
Pickers:						
1st process.......	1.83	1.33	1.17	.83	1.00	1.33
2nd process.1/...	.84	.84	.50	.84	.84	1.01
Total picker loss.	2.67	2.17	1.67	1.67	1.84	2.34
Card: 1/						
Visible..........	4.35	4.18	4.73	4.88	4.81	4.36
Invisible........	2/.18	2/.00	2/.18	2/.18	2/.18	2/.35
Total card loss...	4.17	4.18	4.55	4.70	4.63	4.01
Total picker and card loss 1/	6.84	6.35	6.22	6.37	6.47	6.35

1/ Based on weight of cotton fed to 1st picking process.
2/ Invisible gain.

All these cottons were low in waste content, as is evidenced by the fact that 168 samples of Middling cotton in the 1935 and 1936 crop regional

variety tests averaged 8.37 percent picker and card waste. It has been shown that "location," that is, the type of soil and the weather conditions during the growth and harvesting periods may have a greater influence than variety, as far as manufacturing waste is concerned. For that reason the values in table 3 might have been considerably different if the cottons had been grown under other conditions. Nevertheless, approximately the same relative standing of the varieties with respect to waste could be expected.

Strength of yarn - In table 4 are listed the average strengths of yarn as determined by both the skein and the single-strand test methods, together with some pertinent data from the regional variety tests.

Although these cottons were spun into 50s or 60s for the finest count, it is, of course, recognized that these counts are too fine for the commercial spinning of cottons of such staple lengths. By spinning two or more counts of yarn in making spinning tests, and by approaching the spinnable limit in selecting the finest count, a more complete picture of the spinning quality of a cotton is provided. The strength of any intermediate yarn count can be determined from the count-strength product curves, to be discussed later.

The best single index of yarn strength is considered to be the "weighted average" strength of 22s yarn, the choice of yarn count being simply an arbitrary one. This value is determined by fitting a straight line, using the method of least squares, to the count-strength products of the various yarn counts spun from a cotton, calculating the point at which this line intersects the ordinate for 22s, and dividing this value by 22 to obtain the index in pounds per skein. The final result is thus influenced by all of the yarns spun and should be more representative of the potential spinning quality of a cotton, as far as yarn strength is concerned, than the actual average strength of 22s or any other one count of yarn would be. The weighted average strength is not a perfect index, as will be discussed below, but its advantages outweigh its disadvantages and it will continue to be used in this work until some better measure is devised.

In figure 1 have been plotted the weighted average skein strengths of 22s yarn as determined for the six cottons, together with comparable values from two different sources. One set of values represents the average yarn strengths obtained for cottons of corresponding staple lengths in the regional variety tests, 1935 and 1936 crops. The other set was derived from a formula developed in the laboratories of the Agricultural Marketing Service from tests of many kinds of American Upland cotton conducted over a period of several years. This formula is

Table 4. - Staple length of cotton, twist multiplier, and strength of yarn manufactured from the test samples of cotton

Variety	Staple length	Yarn count	Yarn twist multiplier	Strength of yarn: Skein Av.	Strength of yarn: Skein SE	Strength of yarn: Single strand Av.	Strength of yarn: Single strand SE	Weighted av. skein strength 22s	Yarn strengths for same staple lengths 1935-36 Regional Variety tests: No. samples	Yarn strengths for same staple lengths 1935-36 Regional Variety tests: Wt. av., 22s
	Inches			Pounds	Lb.	Ounces	Oz.	Pounds		Pounds
Coker 100-2-1	1-3/32	22s	4.05	111.52	±.65	15.34	±.096	111.01	15	116.61
		44s		44.97	.33	6.42	.058			
		60s		28.38	.21	4.25	.050			
D. & P.L. 11A	1-1/32	22s	4.20	104.72	.75	14.60	.092	103.45	38	104.72
		44s		40.17	.44	6.02	.068			
		60s		25.86	.19	3.89	.043			
D. & P.L. 12	1-1/32	22s	4.20	103.60	.66	14.39	.091	102.61	38	104.72
		44s		42.17	.35	6.22	.059			
		60s		28.04	.22	4.12	.043			
Delfos 6	1-3/32	22s	4.05	114.00	.77	15.27	.097	113.23	15	116.61
		44s		46.91	.28	6.77	.060			
		60s		30.78	.20	4.24	.046			
Miller	15/16	22s	4.45	104.00	.72	15.09	.090	102.19	91	96.50
		36s		50.57	.27	7.89	.072			
		50s		31.84	.29	5.13	.053			
Stoneville 2B	1-1/16	22s	4.10	110.44	.96	16.32	.100	109.86	32	107.76
		44s		45.91	.32	6.57	.052			
		60s		30.02	.25	4.20	.038			

as follows:

$$S = \frac{660.9 + 1977.8\,L - 22.36C}{C}$$

in which S is the skein strength of carded warp yarn spun with the twist multiplier that will result in the greatest strength
L is the staple length of the cotton, as determined by the cotton classer
and C is the count or number of the yarn.

It should be pointed out that this formula is subject to change as more data become available.

The data obtained from the regional variety tests represent, in the main, pure-bred varieties grown under the best conditions available at the several locations. The material on which the AMS formula was based, on the other hand, included cottons that were grown, harvested, and ginned under many different conditions, including favorable as well as unfavorable. This explains, in part, why the values for the Regional Variety cottons are considerably higher than those of the second set.

All of the cottons in this test produced stronger yarns than the values for the same staple lengths obtained with the AMS formula. Only two of the varieties, Miller and Stoneville 2B, produced stronger yarns than the averages for corresponding staples in the regional variety tests. For its staple length, 15/16 inch, the Miller variety was much the best of the six cottons with respect to strength of 22s yarn, exceeding the average for 91 regional variety cottons of this length by 6 percent, and the value obtained with the AMS formula by 11 percent.

From a consideration of the weighted average skein strengths of 22s yarn, it might appear that the D. & P. L. 11A was slightly superior to the D. & P. L. 12, although the small difference in favor of the 11A strain is not statistically significant. By reference to table 4, however, it will be seen that the finer yarns are stronger for the D. & P. L. 12. Thus, other things being equal the D. & P. L. 12 would probably be the more desirable cotton.

It is believed that a more accurate and complete picture of the yarn-strength relationships of these six cottons can be obtained from figure 2, which shows the count-strength product curves. The count-strength product for a particular yarn is merely the product of the yarn number and the average strength in pounds per skein. It can be shown that the count-strength product of a yarn is proportional to the stress per unit cross-sectional area of the yarn. The use of count-strength product curves permits comparisons of the spinning potentialities to be made of two or more cottons, even though the same yarn

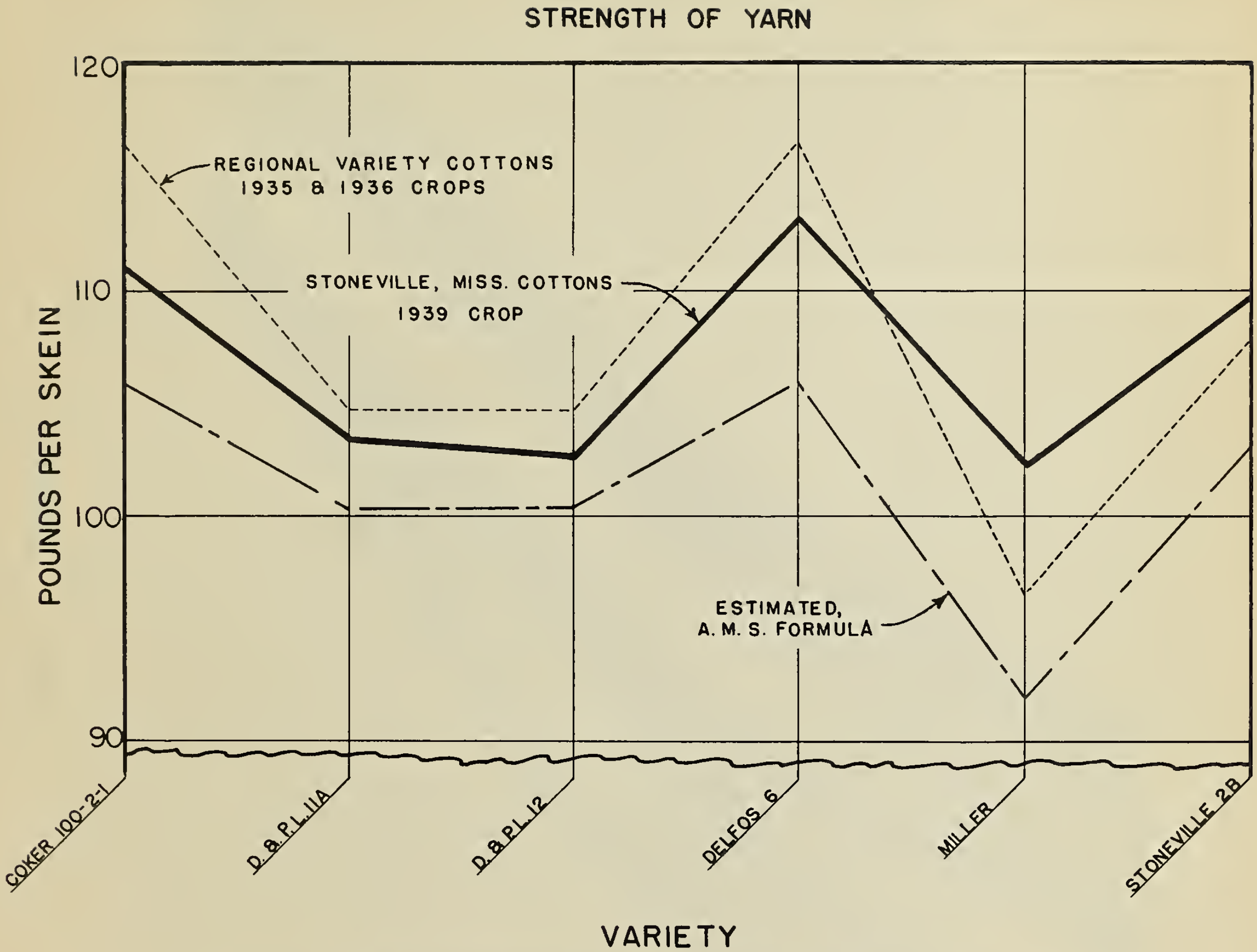

FIGURE 1.- WEIGHTED AVERAGE SKEIN STRENGTH OF 22S WARP YARN, BY VARIETY.

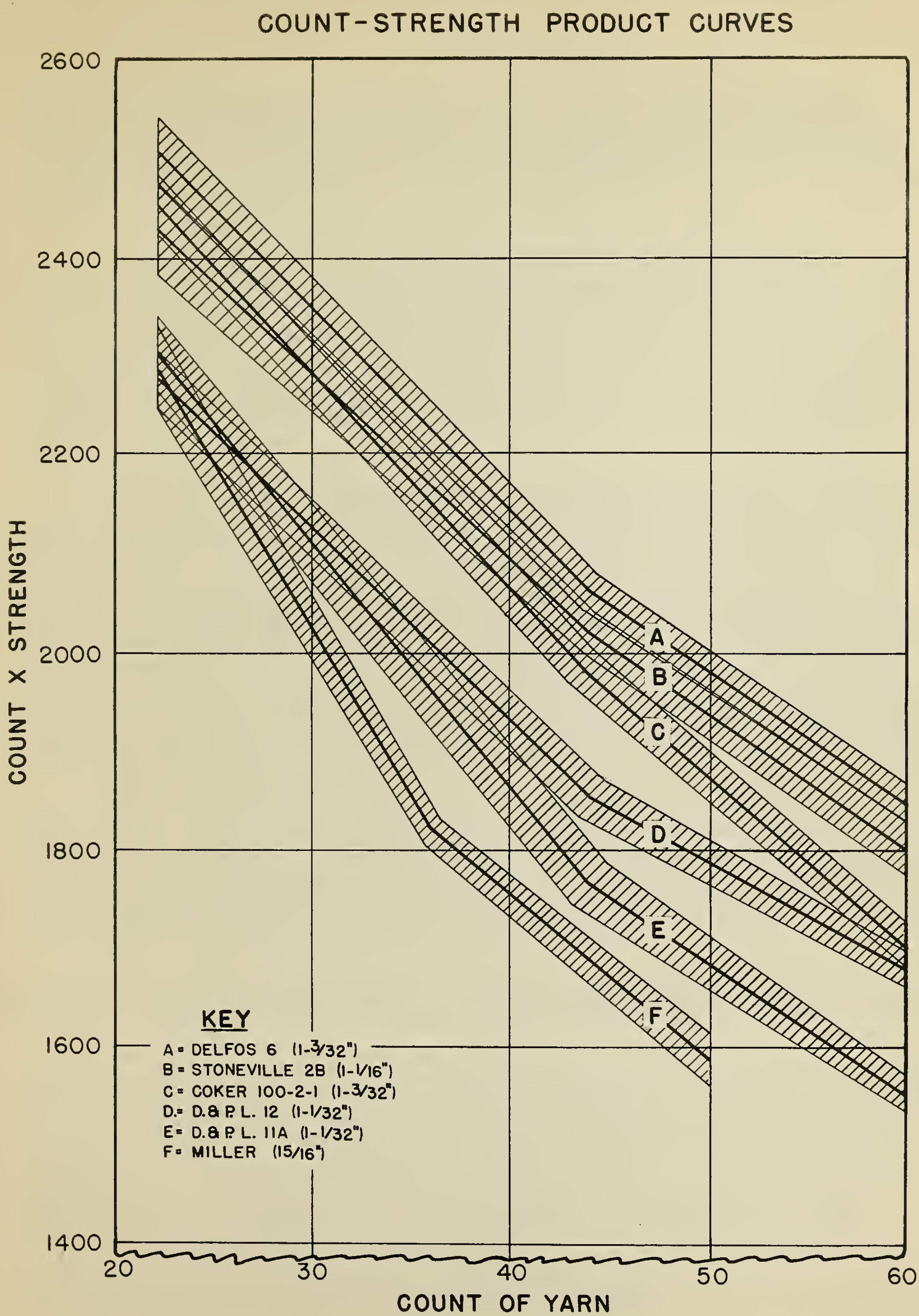

FIGURE 2.– COUNT-STRENGTH PRODUCT CURVES FOR YARNS SPUN FROM THE SIX COTTONS. WHERE THE SHADED AREA FOR ONE LINE OVERLAPS THAT FOR ANOTHER, THE DIFFERENCE BETWEEN THE VALUES IS NOT SIGNIFICANT (ODDS: 1 TO 19).

numbers may not have been spun from each, if the over-all range of numbers is approximately the same. In addition to this, the probable strength of any intermediate count can be determined by interpolation, or estimated with the use of an empirical formula developed in the laboratories of the Service. 6/

In figure 2, each count-strength product curve is bordered by a shaded area the width of which is dependent upon the dispersion of the individual skein-breaking strengths from which each average was calculated. 7/ It can be shown that if two shaded areas touch or overlap, the difference between the two count-strength values on that particular ordinate is not significant, with odds of 1 or more to 19. If there is a space between two shaded areas, the difference between the values is probably significant.

The calculated standard error of the mean yarn strength refers to the dispersion of the strength of the 25 to 50 skeins of yarn. All of these skeins were made, of course, from a single 5-to-10- pound sample of raw cotton. Accordingly, this standard error cannot in any way reflect the degree to which the sample represented the "universe" from which it was taken. Neither can it reflect any error in manufacturing or testing technique that would result in a bias; that is, any error that would cause the entire group of breaking strengths to be too high or two low. If all possible care is exercised in sampling, manufacturing, and testing, however, the dispersion of the individual skein-breaking strengths should aid in indicating the potential quality of the cotton.

The three longest-fibered cottons, Delfos 6, Stoneville 2B, and Coker 100-2-1, were quite similar with respect to the strengths of different counts of yarn. The differences in the strengths of 22s might reasonably be attributed to chance, and even for the other counts Delfos 6 and Stoneville 2B are not significantly different. In the finer counts, the strengths of the Coker 100-2-1 yarns are seen to fall off somewhat.

Delfos 6 is consistently the highest in strength of yarn. As shown in table 2, it was found to be the longest-fibered of the six cottons.

The relationship of the two strains of D. & P. L. cotton mentioned previously is brought out quite clearly in figure 2. The rate of decrease in the count-strength products as the yarns become finer is considerably less for strain 12, a feature which might be of some importance in the

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6/ Campbell, Malcolm E. An Improved Method for Converting an Observed Skein Strength of Cotton Yarn to the Strength of a Specified Count. U. S. D. A. Cir. No. 412, October 1936.
7/ In figure 2 the width of the shaded area in each case is $\pm\sqrt{2}$ x the standard error of the mean count-strength product.

manufacture of yarns of a medium-to-fine counts. The strengths of the Miller yarns fall at a somewhat higher rate than those of the other cottons. This may possibly be due to its shorter staple length, as a tendency toward slightly greater slopes has been observed for shorter cottons.

The slight bend in the curves in the region of the intermediate counts is probably due to the fact that spinning frame drafts were greater for the intermediate and fine numbers than for the 22s yarn. It has been found that, other factors remaining constant, yarn strengths decrease as spinning drafts increase.

Single strand strengths were obtained by the use of a Moscrop tester modified to operate at a speed of 12 inches per minute during the application of the load. The results are presented mainly for possible use by manufacturers who evaluate their yarn strengths in terms of single-strand strengths rather than skein strengths. In general the agreement is close. The high single strand strength recorded for the 22s yarn spun from Stoneville 2B is somewhat out of line. No reason for this can be found, however, in the information available.

The strengths of the yarns spun from these cottons have been discussed in detail, because, in general, yarn strength is the most important single index of cotton quality. Stronger yarns usually reflect lower manufacturing costs, for several reasons. In the first place, the rate of spinning-end breakage will be lower, which sometimes means that an operative can tend more spinning frame "sides," with a corresponding decrease in spinning cost. Secondly, stronger yarns are less likely to break on the loom during weaving, and in turn this will mean higher production per loom and possibly more looms per weaver. Finally, stronger yarns usually will produce stronger cords and fabrics, other things being equal. There are some cotton materials, of course, in which strength is only a secondary factor, but for the most part this is the exception rather than the rule. The foregoing reasons will explain why a manufacturer usually prefers, and frequently will pay more for, cotton that will give high yarn strength. Thus, in most spinning tests the greatest attention is given to the factor of yarn strength in evaluating the results.

<u>Strength of cord</u> - Table 5 shows a rather striking lack of agreement between the staple lengths of the six cottons and the strengths of the tire cords made from them. Omitting the Stoneville 2B cotton, the cord strengths cover a somewhat narrow range, less than 5 percent of the mean strength.

The Miller and Stoneville 2B cottons produced cords practically equal in strength to the averages obtained for cottons of like staple lengths in the regional variety tests, 1935 and 1936 crops. The other four cottons ranged from about 2-to-7 percent weaker than the regional variety cottons of corresponding length.

A rather definite inverse correlation between cord strength and percentage elongation at the 10-pound load is noted, but no explanation for this is at hand. Because no such relationship has been observed in other tests involving considerably larger numbers of cottons, it may be attributed to chance in this case.

These cord data are presented here chiefly for the consideration of tire-cord manufacturers or others who may be interested in these varieties from the standpoint of their adaptability for such material.

Appearance of yarn - The appearance grades of the coarsest and finest yarns spun from each of the cottons are listed in table 6. 8/ The Coker 100-2-1, both D. & P. L. strains, and the Miller all produced 22s of B+ appearance, which is considered good for carded yarn. The 22s yarn spun from Delfos 6 and Stoneville 2B, while one-third of a grade lower, are nevertheless of fairly good quality as far as this factor is concerned.

In general it is found that finer yarns are of somewhat lower appearance grade than coarse yarns from the same cotton. This is because imperfections of a particular nature or size are more noticeable in finer yarns. It is not surprising, therefore, to observe that the 60s yarns are from two-thirds of a grade to one full grade lower than the 22s in the case of the cottons in this test. Because it produced 22s of grade B+ and 50s of grade B, the Miller variety is considered the most desirable of the six cottons from the standpoint of appearance. Previous tests have indicated that shorter cottons tend to produce yarns that are more uniform and freer of neps than longer-stapled cottons.

The number of neps and seed-coat fragments counted on the surface of a 50-yard length of 22s yarn is listed in table 6 for each of the cottons.

There is little close agreement between the grade of 22s yarn and the number of neps, seed-coat fragments or total imperfections. This would indicate that the imperfections were more or less obscured by the bulk of the cotton in the 22s yarn, and that the differences in appearance were due mainly to unevenness in drafting. On the other hand, there is a fairly close agreement between the appearance grade of the finer yarns and the number of neps in 50 yards of 22s. (The finer yarns were not subjected to this type of examination, but it is reasonable to assume that the number of imperfections in the coarse and the fine yarns would be proportionate.)

8/ Grades for yarn appearance are described in the report, "Standards for the Appearance of Cotton Yarn," by M. E. Campbell, U. S. Dept. of Agr., (multilithed) April 1940.

Table 5. - Staple length of cotton, and strength and elongation of 23/5/3 tire cord

Variety	Staple length	Av. strength of tire cord 1/	Av. elongation of cord at 10-lb. load	Cord strength for same staple lengths, 1935-36 R. V. tests	
				Samples tested	Av. strength
	Inches	Pounds	Percent	Number	Pounds
Coker 100-2-1	1-3/32	18.6	12.98	15	19.60
D. & P.L. 11A	1-1/32	18.8	12.28	36	19.13
D. & P.L. 12	1-1/32	17.9	14.16	38	19.13
Delfos 6	1-3/32	18.3	13.02	15	19.60
Miller	15/16	18.4	12.34	91	18.47
Stoneville 2B	1-1/16	19.3	12.30	32	19.29

1/ Corrected to 1050 yds. per lb. and 6.5 percent moisture regain.

Table 6. - Appearance grade of yarn, and number of imperfections in yarn

Variety	Appearance of yarn			Imperfections in 50 yards of 22s yarn		
	22s	50s	60s	Neps	Seed-coat fragments	Total imperfections
	Grade	Grade	Grade	Number	Number	Number
Coker 100-2-1	B+	---	B-	36	15	51
D. & P.L. 11A	B+	---	C+	42	18	60
D. & P.L. 12	B+	---	B-	20	14	34
Delfos 6	B	---	C+	24	12	36
Miller	B+	B	---	16	20	36
Stoneville 2B	B	---	B-	28	10	38

Manufacturing behavior - Detailed notes made during the manufacturing of the six cottons indicate that they showed no unusual spinning characteristics, and that they passed through the successive processes without difficulty. Some neps were noted in the card web, the appearance of which was described as "average to rough." Any tendency toward roughness, however, was evidently remedied at the drawing frame, where all of the webs were considered to be of average appearance. The quantity of fly observed at the card, drawing frame, and roving frames was considered average in each instance except for the Miller variety, which appeared to throw off somewhat more than the average quantity of flyings. Such a tendency is usually associated with the presence of an unusual proportion of short fibers, of immature fibers, or of brittleness. As shown in table 2, the Miller was both fairly uniform in fiber-length distribution and highly mature. No measure of brittleness is available, but it is possible that the heavier fibers of the Miller cotton were more easily broken than those of the finer-fibered cottons by the action of the drafting rolls on the roving frames.

Rates of end breakage during spinning were low for all of the cottons in the coarse and intermediate yarn counts. Even in the spinning of 60s, a rate of only 4 ends down per 100 spindles per hour was found for the Coker 100-2-1 and the Delfos 6. This would probably not be considered excessive in commercial spinning. The other four cottons, however, were found to have rates of end breakage of 12 or more ends down per 100 spindles per hour for the finest yarn counts, which would be too high for satisfactory commercial spinning. It is recognized, of course, that these fine yarn counts are considerably above the commercial spinning range generally accepted for cottons of these staple lengths.

SUMMARY

Spinning and fiber tests were made on six cottons which had not been included in the regular regional variety series, crops of 1935, 1936, and 1937. The six cottons were grown on the Delta Experiment Station plots at Stoneville, Miss., during the 1939 season, and included the following varieties or strains: Coker 100-2-1, D. & P. L. 11A, D. & P. L. 12, Delfos 6, Miller, and Stoneville 2B.

Tests of fiber length, Chandler bundle strength, fineness, and maturity were made in the fiber laboratory. Spinning tests yielded information on manufacturing waste, yarn strength (both skein and single strand), cord strength, yarn appearance, and general manufacturing behavior.

Laboratory fiber tests showed that the array lengths assumed about the same relationships as the staple lengths assigned by the classers, although the Delfos 6 was found in the laboratory to be significantly longer than any of the others. Miller was the most uniform in length, the shortest, coarsest, and the least immature. Chandler bundle strengths for the six cottons were neither outstandingly high nor low. Five of

them, however, were below 80,000 pounds per square inch in bundle strength. Such figures for strength are considered only fair and may be due, in part, to the somewhat unusual growth conditions.

Picker and card waste losses ranged from 6.22 to 6.84 percent, which may be considered a fairly close agreement for six different cottons. Also, these percentages are quite low for cotton of about Middling grade. An average of 8.37 percent was found for 168 samples of this grade in the regional variety tests, 1935 and 1936 crops.

In general, the data reported show the longer the cotton the stronger the yarn or, in other words, the cottons rank in about the same order when compared on a basis of either fiber length or yarn strength. Although all of the cottons produced stronger yarns than the values for corresponding staple lengths obtained with the AMS formula, only two of the varieties, Miller and Stoneville 2B, produced yarns that were equal to or stronger than the averages obtained for similar lengths of cotton in the 1935 and 1936 regional variety tests. For its staple length, 15/16 inch, the Miller was much the best of the six samples with respect to the strength of 22s yarn.

On the basis of weighted average strength of 22s yarn, the D. & P. L. 11A strain was not significantly different from the D. & P. L. 12 strain. The finer yarns of the No. 12 strain, however, were definitely stronger than those of the No. 11A, so that No. 12 would probably be considered slightly the better cotton.

The agreement of single strand strengths and skein strengths was fairly close, but cord strengths presented a somewhat different aspect. Cord strength for Stoneville 2B was somewhat higher than those for the other five cottons, which grouped themselves within a surprisingly narrow range. Miller and Stoneville 2B were about equal in cord strength to the regional variety test averages for their particular staple lengths, but the others were from 2 to 7 percent weaker than the corresponding averages for their respective lengths.

All of the cottons in the test produced yarns of fairly good appearance. The somewhat lower grades of fine yarns are in line with what might be expected. There was little close agreement between the appearance grade of the 22s yarn and the number of neps, seed-coat fragments, or total imperfections in 50 yards of yarn, which indicate that these imperfections were more or less obscured by the bulk of the cotton, and that appearance differences were due mainly to differences in evenness of drafting. There was a fairly good agreement, however, between the appearance grades of the finer yarns and the number of neps in 22s yarn. No nep counts were made on the finer yarns.

No unusual manufacturing characteristics were observed during the processing of these cottons, which were passed through the different machines without difficulty. Spinning-end breakage was low for all the samples at the coarse and intermediate counts, and even in the finest

counts the rate of breakage for Coker 100-2-1 and Delfos 6 was not excessive for commercial spinning. For the finest counts of the other four cottons, end breakage was too high for satisfactory commercial spinning. It is recognized, however, that these fine yarn counts are considerably above the generally accepted commercial range for cottons of these staple lengths.